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ABSTRACT

Studied were eight sections of kindergarten children taught by four teachers in the Glenwood Public School, Ada, Oklahoma. Four experimental sections used the SCIS Material Objects elementary school science activities during the 1969-70 school year. Four control sections participated in other non-structured and less sequential science activities. Investigated were: 1) appropriateness of unit for kindergarten; 2) children's interest; and 3) achievement in reading readiness, reading, arithmetic, mental ability and Piaget conservation task scores. Conservation and ability tests were administered before and after treatments. Reading readiness and arithmetic and reading achievement tests were administered as posttests. Investigator developed evaluation booklets and an interest instrument was used during the science unit. It was concluded that: 1) the SCIS Material Objects unit was appropriate for and of interest to kindergarten children; 2) teacher differences were apparent; 3) enhancement of readiness and first grade achievement was not clearly demonstrated; and 4) ability to perform Piaget Conservation tasks was significantly increased. (Author/JM)

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Final Report

Project No. O-G-106
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An Evaluation of the Science Curriculum Improvement Study (SCIS) Material Objects Unit at the Kindergarten Level

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February 15, 1971

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SUMMARY

An Evaluation of the Science Curriculum Improvement Study (SCIS) Material Objects Unit at the Kindergarten Level

Introduction

The purpose of this research was to evaluate the Science Curriculum Improvement Study (SCIS) Unit, Material Objects in kindergarten. The evaluation was done in four areas or to answer four specific questions.

1. Are the activities and concepts of the Material Objects unit appropriate for kindergarten age children in terms of their abilities to deal with them effectively?

2. Are the activities of the Material Objects unit of such a nature that they interest kindergarten age children?

3. Will administering the Material Objects unit to kindergarten children significantly enhance their readiness for the tasks they encounter in first grade? The readiness aspect of the research will be approached in two ways.

   A. Will a group of kindergarten children have had Material Objects score higher on standardized readiness tests than a comparable group which has not had Material Objects?

   B. Will a group of kindergarten children who have had Material Objects score significantly higher on Piaget Conservation Tasks which are used to determine the child's ability to use simple logic?

4. Will the cognitive stimulation of the Material Objects unit activities significantly improve intellectual functioning in kindergarten age children?

The first two of these specific questions directly involve stated or implied claims of the developers and publishers of the unit. Questions 3 and 4 are goals which, if accomplished, would definitely be considered an asset or extra benefit of the Material Objects unit.

This research was done in Glenwood Kindergarten, Ada, Oklahoma. Four classes (15 students per class) were designated as 'Experimental' and four classes were designated as 'Control.' The kindergarten classes were one-half day, either morning or afternoon. Each class had the same kindergarten program except for science. The Experimental classes used the SCIS Material Objects unit. The Control classes had a science table, were told stories related to science, went on nature walks, etc. Four teachers were involved in the research. Each teacher had one Experimental and one Control class. Two Experimental classes and two Control classes were taught each morning and each afternoon.

Data Collection

The instruments used to collect data were:

1. A booklet containing the stated objectives for each Material Objects activity and a scale for use by the teacher in evaluation of each child on the stated objectives was kept by each teacher for her experimental class. The records kept by the teachers were subject to evaluation by the project director and assistant.

2. An expression by each child of his attitude toward each activity was obtained immediately following the activity. This was accomplished by letting the child mark with a crayon a happy-face if he enjoyed the activity--a sad-face if he did not.

3. Piaget Conservation Tasks were administered pre- and post to all pupils.

4. Metropolitan Readiness tests were administered to all pupils near the end of the school year in May.

5. Mental Ability Tests (SRA K-1) were administered pre- and post to each pupil.

6. California Achievement Tests (arithmetic and reading) were administered to the children involved the previous year in the research during the third month of first grade.

Analysis and Evaluation

The data was evaluated using the IBM 1130 computor. A mathematician and computor specialist conducted the statistical analysis of the data. Tests of significance were done using the Fisher t and Chi Square. The categories and sub-categories chosen for comparison of the research were:

1. Overall Experimental vs Overall Control
2. Male - Female
3. I.Q. divisions (above 110; 90-110; below 90)
4. Socio-economic status

Conclusions

The answers provided by the data to questions 1 and 2 are "yes." The evaluation by the teachers indicated a 90 percent positive response on the accomplishment of stated objectives, and an overall 94 percent positive response on whether the children liked the Material Objects activities. Kindergarten children can effectively deal with the concepts and activities of Material Objects and they enjoy doing so.

The data are inconclusive concerning questions 3 and 4. The Experimental group outscored the Control group by several points on all bases of comparison on the Metropolitan Readiness test, but none of the differences were significant at the .05 level of confidence. (Overall average scores, Experimental group 61.78; Control group 58.27). The Experimental group also outscored the Control group on the California Achievement Tests in arithmetic and reading. The differences in average scores in Reading (Experimental 51.13; Control 46.40) and Arithmetic (Experimental 49.51; Control 46.74) are not statistically significant at a high level of confidence.

The differences in the gains in conservation ability measured by performance on six Piaget conservation tasks is statistically different at the .01 level in favor of the Experimental group.

Both Experimental and Control groups gained in overall I.Q. during the kindergarten program. The Experimental group average gain was 5.40; the Control group average gain was 3.78. The difference, however, is significant only at the 0.6 level of confidence using t values. Most of the advantage of the Experimental group was gained in the below 90 I.Q. division and the above 110 I.Q. division. The average increase per child in the Experimental groups in the below 90 I.Q. division in the area of perceptual I.Q. was 24.70 compared to 12.72 for the Control group. Also, in the area of spatial I.Q., the average gain of the Experimental group was 16.70 compared to 8.29 by the Control group.

There is a definite need for furthur study concerning the specific types of activities which bring about the I.Q. gain.

CHAPTER I

Background of the Study

Many school systems across the United States have recently initiated a public kindergarten program or are planning to do so in the near future. One of the important considerations for educators who wish to coordinate the kindergarten program with other aspects of the existing educational program is, "What should be included in the kindergarten curriculum?"

There are, however, certain self evident criteria which might be used to evaluate activities proposed for the kindergarten program. First, are the activities appropriate to the stages of physical and intellectual development of the kindergarten age child? If activities are provided which require a level of physical or cognative development which does not already exist, the child can not achieve success and will only become frustrated. The optimum program of activities would, of course, be one which assures a high degree of success but at the same time, tempts the child into higher levels of development. Secondly, are the activities of such a nature that kindergarten children enjoy them? It is very important that the beginning formal educational experiences be of such a nature that children experience the joy of learning and associate learning with feelings of pleasure. In addition to the value of the experiences as they relate to future educational experiences, the kindergarten program should help each child live to the fullest that particular period of his life. And thirdly, are the activities of the kindergarten program of such a nature that they help the child in future learning experiences? In other words, the kindergarten program should enhance the learning potential of the child.

All programs produced for use in kindergarten should be subjected to thorough and impartial investigation to determine whether or not they are really suited for use at that level. This investigation can not be based primarily on what sounds logical and appealing to adults. It must be tried with children. An important part of such an evaluation that must not be overlooked is what the children themselves think of the program.

The primary purpose of this research was to evaluate one of the recently developed units of study which is recommended for use in kindergarten. This unit, Material Objects,[1] is a first year unit of the Science Curriculum Improvement Study (SCIS). Although the activities of the Material Objects unit have been used by many kindergarten teachers, there has been no comprehensive evaluation of the effectiveness of the activities of the unit in kindergarten reported in the literature. The purpose of this investigation was to make such a comprehensive evaluation of the Material Objects unit activities in kindergarten.

The evaluation of the Science Curriculum Improvement Study first year program for use in kindergarten was done in four different areas. The questions this research attempted to answer were:

1. Are the activities and concepts of the Material Objects unit appropriate for kindergarten age children in terms of their abilities to deal with them effectively?

2. Are the activities of the Material Objects unit of such a nature that they interest kindergarten age children?

3. Will administering the Material Objects unit to kindergarten children significantly enhance their readiness for the tasks they encounter in first grade? The readiness aspect of the research will be approached in two ways.

   A. Will a group of kindergarten children have had Material Objects score higher on standardized readiness tests than a comparable group which has not had Material Objects?

   B. Will a group of kindergarten children who have had Material Objects score significantly higher on Piaget

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[1] Material Objects, The Science Surriculum Improvement Study, University of California, Berkeley Project Director, Robert Karplus. A description of the Material Objects unit and the teaching method employed is given in Appendix 1.

Conservation Tasks[2] which are used to determine the child's ability to use simple logic? A longitudinal study conducted by Millie Almy allowed her to draw these conclusions concerning conservation performance.

". . . the findings in our studies of a rather substantial correlation between performance in conservation tasks and progress in beginning reading suggests that, to some extent, similar abilities are involved. A program designed to nurture logical thinking should contribute positively to reading readiness."[3]

"The correlations between progress in conservation and the various measures of mental aptitude and achievement are substantial enough to indicate that the child's ability to conserve is relevant to the tasks he encounters in the classroom."[4]

Stafford,[5] in a recent study with first grade children found that the SCIS first grade program significantly accelerated their rate of acquisition of conservation ability. The present research was designed to determine if this same influence is observed when the program is used in kindergarten.

4. Will the cognitive stimulation of the Material Objects unit activities significantly improve intellectual functioning in kindergarten age children?

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[2]The conservation tasks used will be Number, Liquid amount, Solid amount, weight, and area.

[3]Millie Almy, Young Children's Thinking. (New York: Columbia College Press) p. 139-40.

[4]Ibid., p. 105.

[5]Stafford, Donald G., The Influence of the First Grade Program of the Science Curriculum Improvement Study on the Rate of Attainment of Conservation, School Science and Mathematics, February, 1971.

Procedure

Glenwood Kindergarten of the Ada, Oklahoma school system provided the subjects for the investigation. Every child in the school was involved either as an experimental or control subject. The four teachers of the Glenwood Kindergarten were experienced teachers and were certified by the Oklahoma State Department of Education. The school day at Glenwood school was divided into four morning classes and four afternoon classes of approximately 15 children each- a total of eight different classes. Each teacher taught one morning and one afternoon class. Two of the morning classes and two afternoon classes were designated as Experimental classes. Two of the morning and two of the afternoon classes were designated as Control classes. Each teacher taught one Experimental Class and one Control Class. It was felt that this arrangement would cancel the teacher factor in the investigation. All of the activities of the Experimental and Control classes were the same except for the science period. The science period which lasted for approximately 20 to 25 minutes was conducted an average of twice weekly. The Experimental classes participated in the activities of the Material Objects units during the science periods; the Control classes had "show and tell" activities, went on nature walks, and participated in informal, less structured, non-sequential science activities. Preparation for the investigation began during the summer of 1969. The project officially began under the sponsorship of the U.S. Office of Education in October, 1969 and extended throughout the kindergarten year. The follow-up phase of the project extended through the first semester of the first grade.

The assistant to the Project Director, Mrs. Wendell Altmiller, was an experienced kindergarten teacher. It was she who worked directly with the kindergarten teachers as a special consultant. Mrs. Altmiller and the regular kindergarten teachers had previously attended special sessions to learn the rationale and teaching method used in the Material Objects unit. Mrs. Altmiller also supervised the utilization of the various evaluatory instruments employed in the research.

Instruments Used to Collect Data

Each child in the Experimental and Control classes were given a pretest during the first two weeks of October, 1969 using six Piaget

tasks. These tasks are described in detail in Appendix III. These same tasks were administered during the first two weeks of May, 1970. The results of this pre- and post testing with Piaget development during this period. Another instrument used to determine the growth in intellectual functioning was the Science Research Associates Primary Mental Abilities Test for grades K-1. Both the pretest administered in October, 1969 and the post-test administered in May, 1970 were administered to the children in both the Experimental and Control groups by the Ada, Oklahoma Guidance Center under the supervision of Dr. Roy Maxwell and Dr. Sidney Pepper, staff psychologists. In order to make a comparison of the effectiveness of the Material Objects activities relative to their assisting in future learning. Metropolitan Readiness Tests, Form B published by Harcourt, Brace and World, Inc. were administered during the last week of May, 1970 to the children in both experimental and control groups. This testing was supervised by the Project Director and assistant.

To determine if the activities and concepts of the Material Objects unit were appropriate to the developmental stage of the kindergarten child, an evaluation booklet was designed by the project director. This booklet, Appendix IV, (one for each child in the Experimental classes) listed each of the objectives exactly as they are stated in the Material Objects Teachers guide. The teacher, assisted by the assistant director, evaluated each child periodically to determine if the child had accomplished the stated objectives. An arbitrary value of 80 percent was selected as the level at which the Experimental group should achieve the stated objectives if the activities were to be considered appropriate for kindergarten children.

In order to determine if the children enjoyed participating in the Material Objects activities, a simple instrument was developed which each child could react to after each class activity. The instrument, Appendix IV, has a picture of a happy face and a sad face on it. Immediately after each activity, the children were instructed to mark with a crayon the happy face if they enjoyed what they had just been doing and the sad face if they had not. Again, an arbitrary figure of 80 percent was established as the level at which the activities overall would be considered as being enjoyed by the children.

A follow-up study of the children in both the Experimental and Control kindergarten classes was done in first grade on those child-

ren who attended first grade in the Ada, Oklahoma system. No attempt was made to do follow-up studies on children who attended other school systems. The follow-up study consisted of administering California Achievement Test (Form W) in Reading and Arithmetic. These tests were administered during the first week of December, 1970. The data collected on each child was placed on IBM computer cards for evaluation. Tests of statistical significance were performed comparing the Control and Experimental groups in the areas of Piaget Tasks, mental age growth, readiness, and progress in beginning reading and arithmetic in first grade. The test of statistical significance used to compare the Control and Experimental groups in the areas of mental age growth, readiness in kindergarten and progress in arithmetic and reading in first grade was the Fischer t. A comparison of the increase in performance on Piaget developmental tasks was done using Chi Square. Mr. James Herndon, computer specialist, East Central State College, provided assistance in setting up the statistical analysis. In addition to the regular members of the research team, Dr. John Renner, Director of the Oklahoma Trial Center for SCIS provided valuable consultant assistance. This assistance was primarily directed toward the solution of specific problems regarding teaching technique.

The categories and subcategories chosen for comparisons throughout the research were:

1. Overall Experimental vs Overall Control

2. Male - Female

3. I.Q. divisions (above 110; 90-110; below 90)

4. Socio-economic status (white collar - blue collar)
   This category was determined by the job and neighborhood of the parents. Generally speaking, all jobs requiring college training were classed as "white collar." Small business men were classified as "white collar" if they lived in a neighborhood which was predominately white collar. Managers and owners of large businesses were classed as "white collar."

CHAPTER II

Presentation of Data

The data collected in this research project will be presented in this section with minimal discussion or evaluation. Comments concerning the tables of graphs will be limited to a brief explanation of the data and explanatory remarks intended to clarify certain points.

Table I applies to the Experimental group only. It is simply a listing of the sixty-four stated objectives of the Material Objects unit. This data was taken from the record of achievement of stated objectives maintained by each teacher for each child in her experimental class. The numbers beside each stated objective are calculated percentages of the number of students achieving the stated behavior in the combined four experimental classes. The third category, undecided, was added by the teachers keeping record because the child was not consistent in his performance. This third category is relatively large in a few cases (7, 43, 48, 52, 57, and 59).

Table I

Achievement by the Experimental Group of Stated Objectives of the Material Objects Unit.

	Percent		
	Yes	No	Sometimes
1. Uses the term object for a piece of matter	84.37	4.68	10.93
2. Uses the term property for any characteristic of a piece of matter.	73.43	15.62	10.93
3. Identifies and describes material objects by their properties, not their use.	64.06	25.00	10.93
4. Describes a collection of objects by their properties.	81.25	10.93	7.81
5. Sorts objects by a chosen property.	73.43	18.75	7.81

		Percent		
		Yes	No	Sometimes
6.	Identifies properties of objects collected on a hunt.	85.93	6.25	7.81
7.	Sorts objects, using one property.	23.43	6.25	70.31
8.	Describes properties of an entire plant.	100.00	0.00	0.00
9.	Describes properties of parts of plants thought of as objects.	98.43	1.56	0.00
10.	Notes similarities and differences among plants.	92.18	7.81	0.00
11.	Observes animals and describes their properties.	100.00	0.00	0.00
12.	Recognizes some relationships between animals and their environments.	96.87	3.12	0.00
13.	Sorts objects by size, shape, color, or other properties.	96.87	3.12	0.00
14.	Groups objects according to different properties chosen by the teacher.	96.87	3.12	0.00
15.	Compares properties of objects.	95.31	4.68	0.00
16.	Compares two objects which have identical properties.	93.75	6.25	0.00
17.	Compares objects in regard to more than one property at a time.	90.62	9.37	0.00
18.	Sorts objects by properties other than size and shape.	75.00	23.43	1.56
19.	Contrasts objects made of one material with objects made of more than one material.	87.50	10.93	1.56
20.	Classifies objects by material.	87.50	9.37	3.12
21.	Distinguishes between objects made of one material and objects made of several materials.	81.25	15.62	3.12
22.	Identifies properties of a metal object.	93.75	3.12	3.12

	Percent		
	Yes	No	Sometimes
23. Identifies similarities and differences among a variety of metallic specimens.	82.81	14.06	3.12
24. Sorts pieces of metal by kind	60.93	32.81	6.25
25. Identifies and sorts pieces of wood by property and kind	78.12	17.18	4.68
26. Applies the concept of material to the task of sorting a collection of pieces of different woods.	57.81	37.50	4.68
27. Identifies properties of objects made of the same material but in different forms.	90.62	9.37	0.00
28.. Realizes that an object's form can change while the material remains the same.	85.93	14.06	0.00
29. Compares sample pieces of pine, oak, and walnut with wood shavings and wood dust, according to properties.	92.18	7.81	0.00
30. Identifies properties of the same material in different forms.	85.93	14.06	0.00
31. Describes rock specimens by property.	90.62	4.68	4.68
32. Recognizes the nonuniformity of material in some rocks.	73.43	20.31	6.25
33. Sorts rocks by kind.	93.75	3.12	3.12
34. Sorts rocks by property when the properties are less well defined.	65.62	31.25	3.12
35. Recognizes some materials which make up rocks in an assortment.	54.68	42.18	3.12
36. Describes properties of different liquid samples.	93.75	3.12	3.12

	Percent		
	Yes	No	Sometimes
37. Describes some properties of gases.	87.50	6.25	6.25
38. Identifies differences between gases.	87.50	6.25	6.25
39. Recognizes and describes an event or series of events in terms of their occurence in time.	84.37	12.50	3.12
40. Compares objects that are not equal in regard to a particular property.	81.25	15.62	3.12
41. Uses comparison signs to indicate comparing by property.	93.75	3.12	3.12
42. Identifies differences within a set of similar objects.	85.93	10.93	3.12
43. Arranges similar objects in serial order according to length or some other property.	57.81	12.50	29.68
44. Describes the properties of shells.	89.06	1.56	9.37
45. Recognizes similar and different properties among shells.	89.06	1.56	9.37
46. Identifies variation among the shells in regard to specified properties.	82.81	7.81	9.37
47. Orders the shells by property, using comparison signs.	71.87	18.75	9.37
48. Uses comparison signs.,	64.06	10.93	25.00
49. Recognizes that the material of an object may remain the same, even though the object's appearance changes.	95.31	0.00	4.68
50. Recognizes that two objects may appear to be different but are still made of the same material.	95.31	0.00	4.68

	Percent		
	yes	no	sometimes
51. Orders liquids by property.	92.18	3.12	4.68
52. Describes the properties of many different liquids.	65.62	6.25	28.12
53. Observes a sample of water change from solid to liquid.	100.00	0.00	0.00
54. Uses the medicine dropper for transferring liquids between containers.	98.43	0.00	1.56
55. Compares different objects in regard to the property of floatability in water.	95.31	0.00	4.68
56. Recognizes that a sample of air may be considered an object.	85.93	6.25	7.81
57. Observes that air occupies space, takes the shape of the container, and is compressible.	62.50	14.06	23.43
58. Investigates some of the properties of samples of air.	82.81	7.81	9.37
59. Observes that air must leave a space before water can fill that space.	59.37	15.62	25.00

Considering the objectives individually, there were seventeen objectives of the fifty-fine evaluated which were below the eighty percent level in the "yes" column. If the overall percentage is considered, the achievement of stated objectives is approximately eighty-three percent with approximately seven percent in the undecided column. This is shown graphically in Graph IA. Graphs IB and IC compare the percentage of children achieving a given percentage of the objectives of the Material Objects unit.

The following activities were not used in the program:

Arranges objects in serial order by some property, using comparison signs.
Describes changes in a mixture of liquids observed over a period of time.
Realizes the relationship between changes in observed properties and a time sequence.
Keeps a record of observations.
Verifies observations by repeating the activity.

Graph I

Achievement of Stated Objectives of the Unit

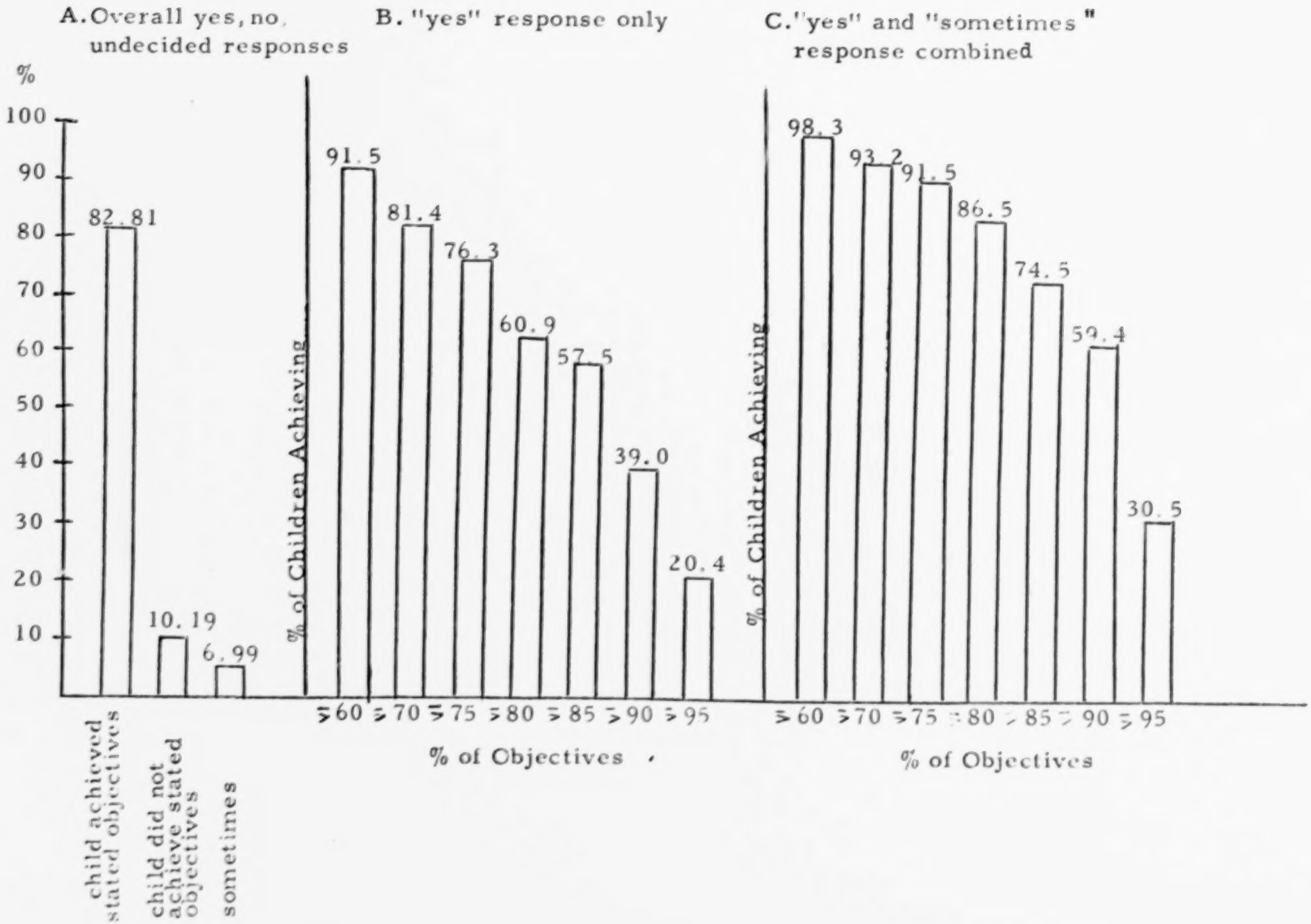

Table II shows in tabular form the number of lessons each of the four experimental classes had on each of the thirty activities in the Material Objects unit. It should be noted that not all classes had lessons in each activity and the number of lessons on an activity varied among classes. In keeping with the rationale of the SCIS program, the teachers were allowed considerable freedom to conduct their classes as they thought best. This included determining the number of lessons for each activity and the order, in some cases, in which the activities were presented. Also shown in Table II is a tabulation by class the results of the indications by the children (happy face, sad face) whether or not they liked the particular activity. The overall percentages for each class are given at the bottom of each column. The percentage of all responses was 94% liked the activity; 6% did not.

Table II

Percent Like-Dislike of Experimental children by activity in the Material Objects program.

Activity	No.of lessons A	B	C	D	Class A L - D*		Class B L - D		Class C L - D		Class D L - D		Totals L - D		% L - D	
1	4	4	4	2	37	17	43	3	41	11	19	4	140	35	80	20
2	4	4	6	5	42	5	42	4	95	4	54	10	233	23	91	8
3	2	2	4	3	24	2	25	2	59	2	36	6	144	12	92	8
4				1							17	0	17	0	100	0
5	1			1	13	4					17	0	17	0	100	0
6	3	10	9	6	36	8	119	4	134	3	74	14	363	29	93	7
7	5	3	3	5	60	0	39	1	42	0	64	6	205	7	96	4
8	2	4	3	2	27	4	47	1	44	0	29	3	147	8	95	5
9	3	4	4	1	38	3	53	0	56	0	13	4	160	7	96	4
10	1	3	4	1	13	0	33	1	52	0	16	0	114	1	99	1
11	3	3	3	3	37	4	40	2	40	0	35	5	152	11	93	7
12	2	2	2	2	25	2	27	0	28	0	26	4	106	6	95	5
13	1	1	1	1	14	0	13	0	17	0	14	3	58	3	95	5
14	1	1	1	1	14	0	12	1	17	0	15	1	58	2	97	3
15	2	1	1	1	22	5	14	0	15	1	13	0	64	6	91	9
16	1	1	1	1	14	2	12	0	15	0	12	1	53	3	95	5
17	1	1	1	1	12	4			15	0	13	1	40	5	89	11
18	1		1	1	14	2			15	0	15	1	44	3	94	6
19	1		1	2	15	1			15	0	27	0	57	1	98	2
20	1		1	1	15	0			15	0	14	1	44	1	98	2
21	1	1	1	1	16	0	12	0	17	0	13	0	58	0	100	0
22			1						15	0			15	0	100	0
23			1	1					15	0	13	0	28	0	100	0
24																
25	1	1	1	1	13	0	12	0	17	0	15	0	57	0	100	0
26			1						14	0			14	0	100	0
27				1	15	0					17	0	32	0	100	0
28	1	1	1	1	11	3	15	0	16	0	16	0	58	3	95	5
29	1		1	1	12	3			15	0	15	0	42	3	93	7
30	2		1	2	22	7			15	0	31	0	68	7	91	9
	45	47	57	49	561	76	588	19	839	21	643	64	2588	176	94	6
					88%	12%	97%	3%	98%	2%	91%	9%				

*L - Like
D - Dislike

Table III shows the scores of Experimental and Control groups on the Metropolitan Readiness Tests. This test was administered in May, 1970 during the last month of kindergarten. The median age of the group when tested was 6.0 years. Also indicated are the values of the t tests comparing the Experimental and Control samples grouped in various ways. One should note that the Experimental samples outscored the Control on every basis of comparison although no t value is significant at a high level of confidence. In general, the Readiness scores were positively related to I.Q. Also, the male experimental group outscored the male control group by an average of 5.3 points. The variance in the male experimental group, however, was quite large.

It might also be noted that the female groups, both Experimental and Control, outscored the male group. Also, the white collar groups, both Experimental and Control, outscored the blue collar groups.

Table III

Metropolitan Readiness Test Comparisons of Experimental and Control Groups.

Group	Score	t	Sig
All experimental All control	61.78 58.27	0.302	0.8
(a) Male Experimental Male Control	60.38 55.07	0.302	0.8
(b) Female Experimental Female Control	62.62 61.38	0.077	0
(c) Blue collar Experimental Control	58.00 54.02	---	---
(d) White collar Experimental Control	68.40 64.55	---	---
I.Q. > 110 Experimental Control	74.07 70.50	0.118	.9
I.Q. 90-110 Experimental Control	62.57 60.84	0.099	0
I.Q. < 90 Experimental Control	46.22 42.92	0.159	.9

These divisions are indicated graphically in Graph II.

Graph II
Metropolitan Readiness Scores

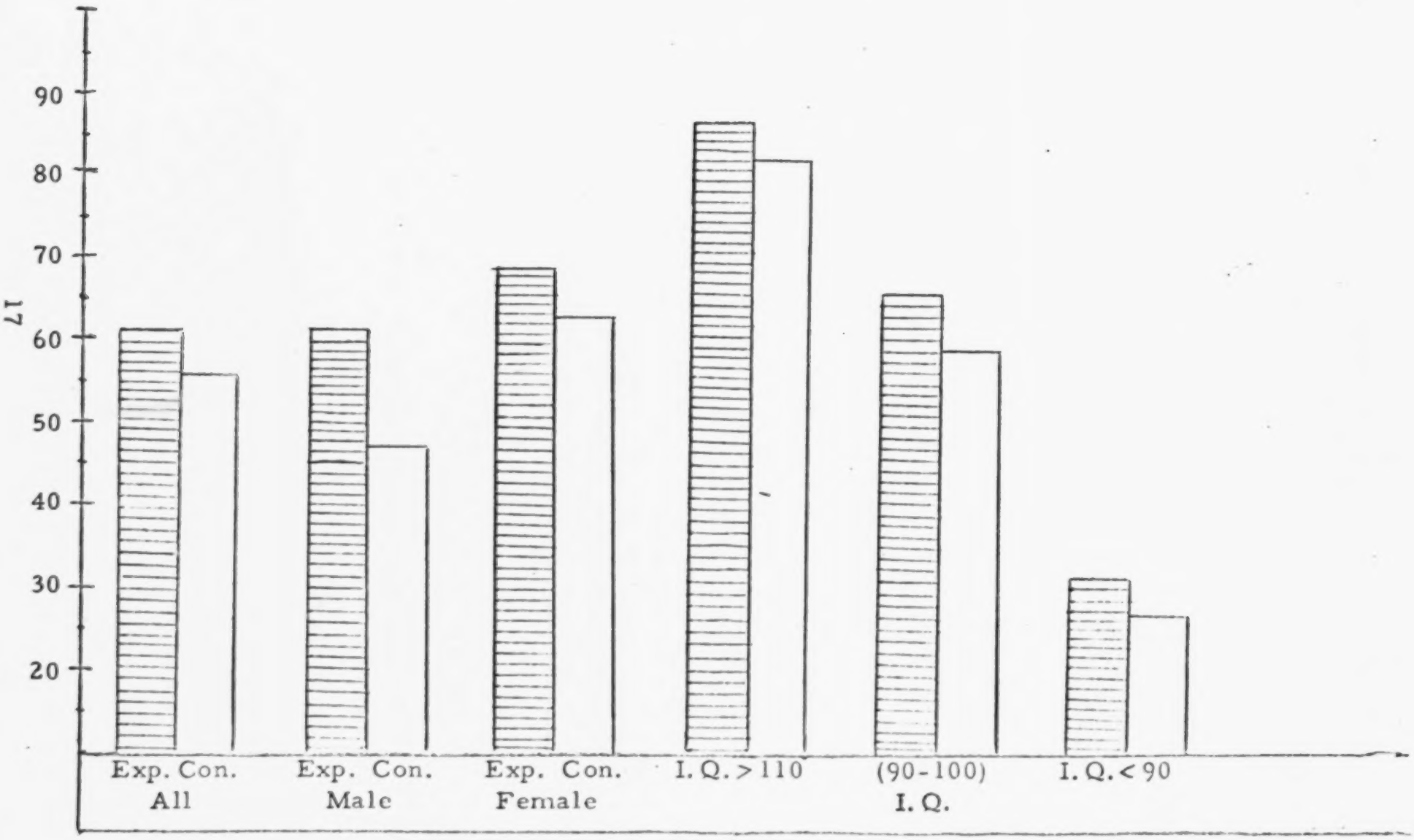

Table IV shows the pre- and posttest results for the Experimental and Control groups by task. The Experimental group has an overall advantage of a gain of 52 conservations to 22 for the Control group. This difference in overall gain is significant at the .01 level of confidence.

Table IV

Piaget Tasks

Task	N=55 Experimental group		N=52 Control group	
	Pretest	Posttest	Pretest	Posttest
Number	35	35	30	34
Length	3	17	7	12
Liquid Amount	3	18	7	8
Solid Amount	7	19	8	13
Weight	3	6	2	2
Area	15	23	14	21
Totals	66	118	68	90
Overall gain		52		22

The tasks on which the scores of the Experimental group was much better than the Control group were length, solid amount, and liquid amount.

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Graph III shows a comparison of the results of the pre- and post-test on the Piaget tasks by indicating the sum of the conservation[6] responses and the non-conservation responses on the Piaget tasks.

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[6]Conservation is used here to indicate that the child followed the transformation of a material from one shape to another and understood that this did not change the amount of material. From an adult point of view, this would be the "correct" response.

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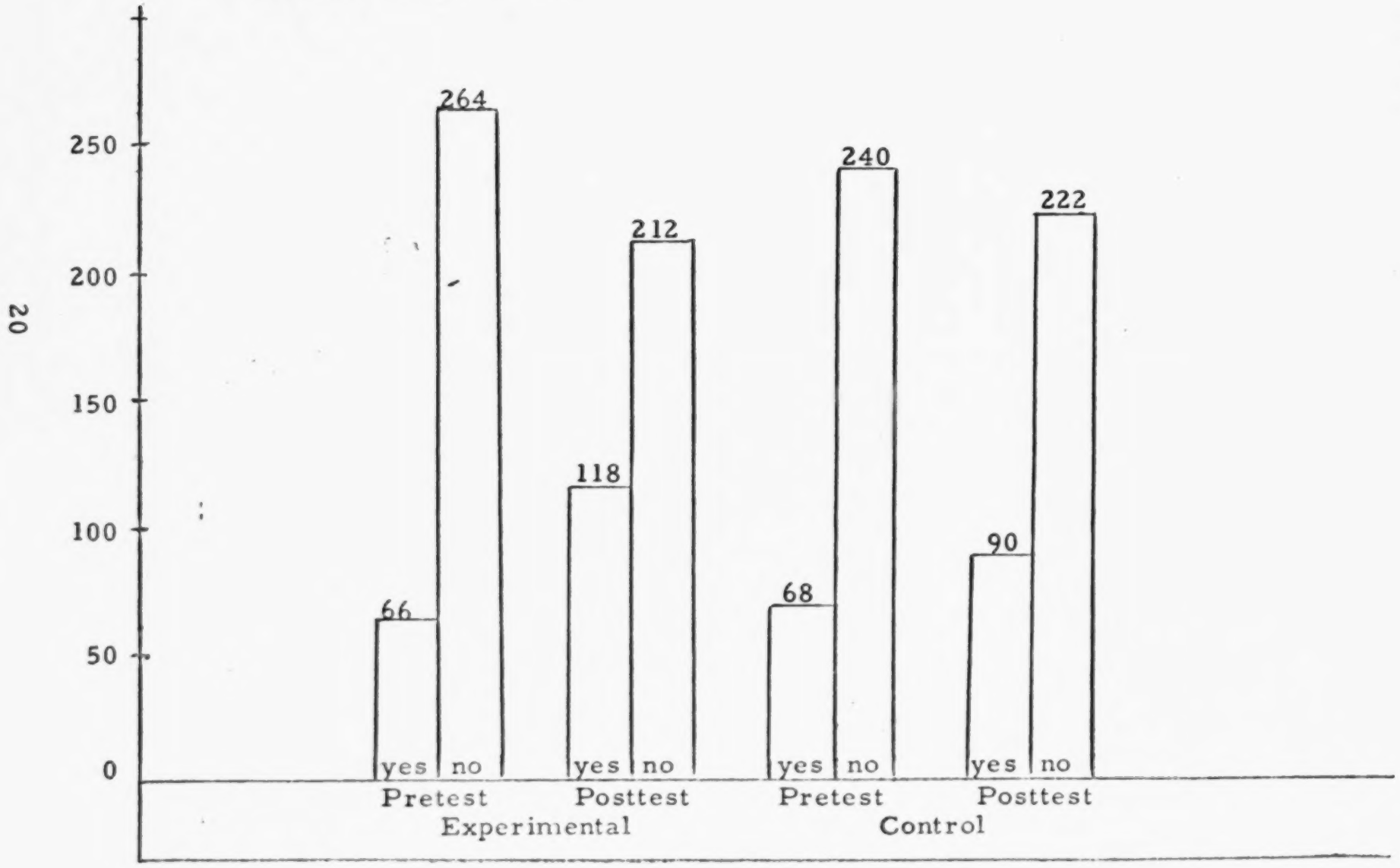
Graph III

Total number of conservations and non-conservation responses by the Experimental and Control groups on the Pre- and Post-tests for Piaget Tasks.



Graph IV

Overall Piaget task gains by the Experimental and Control groups during the kindergarten year as measured by the Pre- and Posttests.

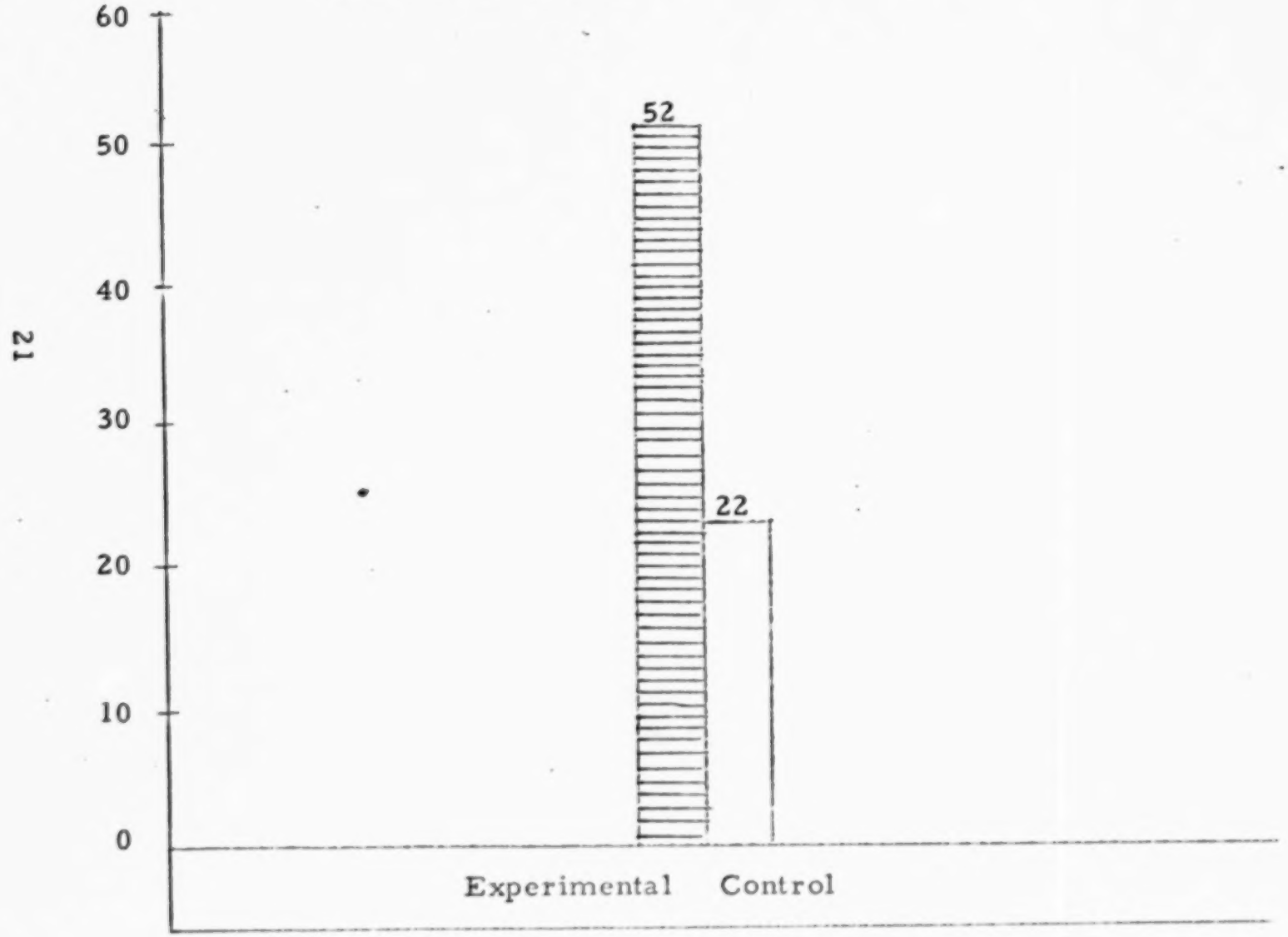


Table V

A comparison of the scores of the Experimental and Control groups in grade one on the California Achievement Test-Form W.

	Experimental Raw Scores	Control	t	Sig.
Reading Vocabulary	46.78	43.14	0.330	.8
Reading Comprehension	4.35	3.25	0.926	0.4
Total Reading	51.13	46.40	0.394	.7
Arithmetic Reasoning	25.91	23.60	0.372	.7
Arithmetic Fundamentals	23.86	23.14	0.115	.9
Total Arithmetic	49.51	46.74	0.225	.8
Sample size	37	35		

California Achievement Tests - Form W
1957 Edition, McGraw-Hill Book Company
Lower Primary Grades 1 and 2
Administered Grade 1, Month 3

Table V shows the scores in the areas of reading and arithmetic of the Experimental and Control groups on the California Achievement Tests-Form W. This test was administered at the end of the third month of grade one. The Experimental group scored higher than the Control group in every area. The margin of difference was not statistically significant at a high level of confidence. The area in which the difference in scores was significant with the highest level of confidence was reading comprehension at 0.4.

Graph V

Comparisons of the California Achievement Test scores for the overall reading and arithmetic scores.

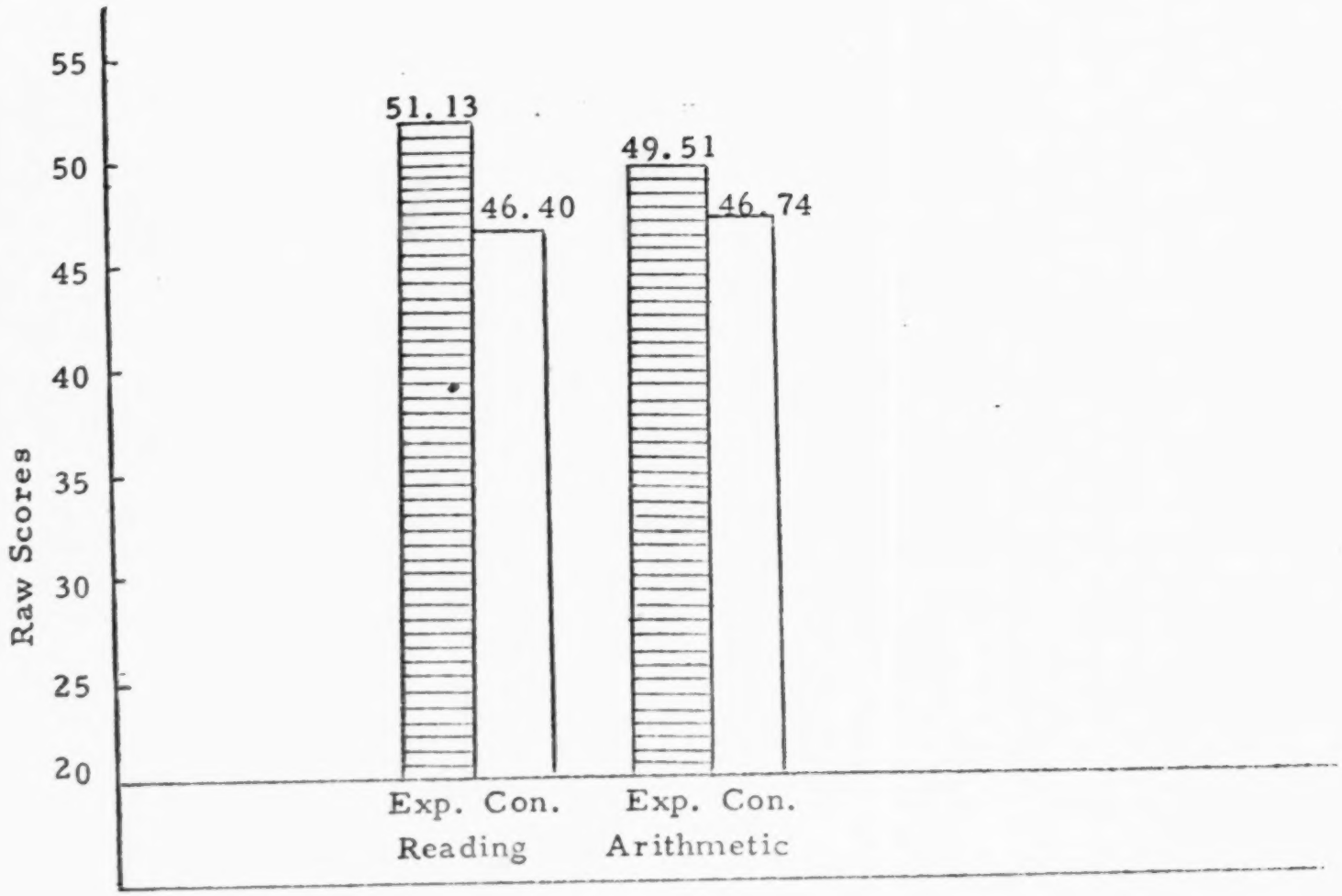


Table VI shows the scores of the SRA (K-1) Mental Ability test. Test 1 was administered in October of the kindergarten year and Test 2 was administered the following May, 1970. In every group except one (the above 110 I.Q. Control group) there was a rise in I.Q. Part of this gain might be attributed to previous experience in taking the test. This argument is weakened, however, by the fact that the one group which had the highest ability (above 110 I.Q.) to gain from such an experience actually scored lower. Even if this factor of previous experience is considered valid, since both Experimental and Control groups had the experience, a valid comparison of the gains can be made.

On every basis of comparison, except one, (the 90-110 I.Q. Control group) the Experimental group gain is greater than the Control group gain. The most significant comparison of gains are the above 110 I.Q. groups and the below 90 I.Q. groups. The below 90 I.Q. group (below average) actually gained enough to move into the average I.Q. range. Although none of the t values are high enough to be significant at the .05 level of confidence, the difference of the gains is great enough that it can not be discounted.

Table VI
A comparison of Mental Ability (I.Q.) scores and gains by the Experimental and Control groups.

Overall	Test 1	Test 2	Gain	t	Sig.
I. Total Experimental	102.30	107.70	+5.40	.461	.6
Total Control	99.41	104.19	+3.78		
II. Female Experimental	103.93	110.51	+6.58	.485	.6
Female Control	101.33	106.73	+5.40		
Male Experimental	101.59	107.09	+5.59	.161	.9
Male Control	96.40	102.20	+5.80		
III. I.Q. > 110					
Experimental	119.33	122.93	+4.71	1.664	.1
Control	115.83	115.33	- .50		
I.Q. (90-110)					
Experimental	101.20	106.96	+5.76	-.348	.7
Control	99.72	107.62	+7.90		
I.Q. < 90					
Experimental	83.90	95.00	+11.10	1.087	.3
Control	83.42	89.42	+6.00		

Graph VI

A comparison of the gains in I.Q. of the Experimental and Control groups subdivided by I.Q.

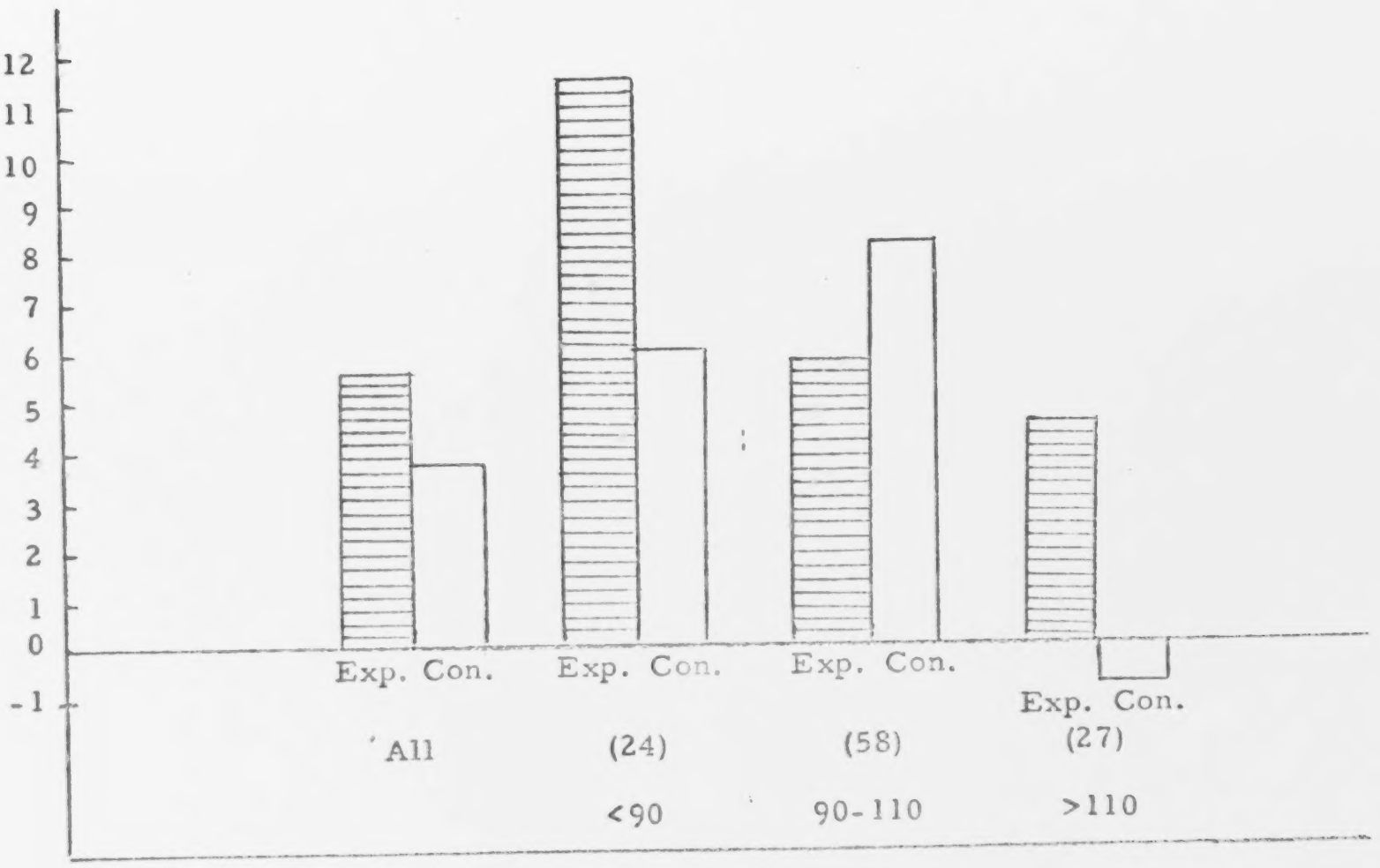


Table VIIshows the scores on the SRA (K-1) Mental Ability tests and the gains of the Experimental and Control groups by test area. The most pronounced gain by both groups was in'perceptual' I. Q. The gain by the Experimental group was much larger than the Control. The t value indicates a significance value of approximately 0.3.

Table VII
A comparison of overall I. Q. changes in the Experimental and Control groups by test area.

	Experimental			Control			
	Test 1	Test 2	ΔI. Q.	Test 1	Test 2	ΔI. Q.	t
Verbal	107.27	106.76	-.51	106.01	107.87	1.86	-.792
Perceptual	103.18	120.49	17.31	99.38	111.65	12.27	1.037
Number	104.03	110.87	6.84	99.20	105.76	6.56	0.106
Spatial	99.00	102.10	3.10	99.09	104.67	5.58	0.511

Table VIII shows the scores on the SRA (K-1) mental ability test for the Control and Experimental groups by test areas and by I. Q. groups. The basis for division of the I. Q. groups was test 1 scores. In the below 90 I. Q. groups, both experimental and control, there was a very large increase in I. Q. in the areas of 'Perceptual' and 'Spatial." The gain in I. Q. by the Experimental group in both of these areas is approximately twice that of the Control group. The t values of comparison of the Experimental and Control groups in these two areas has a significance level of approximately 0.2. A relatively small sample size and a relatively large variance reduced the t value.

In the 90 to 110 I. Q. range, there was a large but approximately equal gain by both groups in the 'Perceptual' area. The overall gain by the Control group over the Experimental was primarily in the areas of 'Number' and 'Spatial.'

In the above 110 I. Q. groups, the Control group generally remained constant except for the area of spatial. In this area, both groups had a decrease in I. Q. The overall advantage of the Experimental group over the Control was gained in the areas of 'Perceptual' and 'Number.' In these two areas the t value is significant in favor of the Experimental group at the 0.2 level of confidence.

Table VIII
A comparison of I.Q. changes by I.Q. group

I.Q. <90	Experimental Test 1	Test 2	ΔI.Q.	Control Test 1	Test 2	ΔI.Q.	t
Verbal	92.90	95.80	2.90	92.92	95.85	42.93	.007
Perceptual	82.70	107.40	24.70	81.42	93.14	+12.72	1.263
Number	79.60	89.20	9.60	83.57	89.21	+5.64	0.713
Spatial	76.60	93.30	16.70	71.71	80.00	+8.29	1.115

I.Q. 90-110	Experimental Test 1	Test 2	I.Q.	Control Test 1	Test 2	I.Q.	t
Verbal	105.93	105.50	-.43	108.17	110.24	2.07	.403
Perceptual	101.46	118.03	16.57	98.10	115.55	17.45	.134
Number	101.96	108.23	5.27	99.00	108.37	9.37	.913
Spatial	97.76	99.40	+1.64	95.48	98.44	6.94	.348

I.Q. >110	Experimental Test 1	Test 2	I.Q.	Control Test 1	Test 2	I.Q.	t
Verbal	119.53	116.60	-2.90	116.08	116.16	0.08	-.020
Perceptual	120.26	134.13	13.87	123.41	123.83	0.42	1.384
Number	124.46	130.60	6.14	117.91	118.75	0.84	1.268
Spatial	116.40	113.40	-3.00	113.25	105.16	-8.09	.772

Table IX compares the I.Q. changes of the Experimental and Control groups when divided into subgroups on the basis of socio-economic status. The subgroups are labeled "white collar" and "blue collar." The basis for division into these two subgroups was parental occupation and neighborhood.

Although each group had a gain in I.Q., the gain was approximately equal in the blue collar subgroup. The white collar Experimental subgroup out-gained the white collar Control subgroup by a factor of 2.3.

Table IX

Comparison of I.Q. changes by Experimental and Control and White Collar and Blue Collar Division

	Experimental			Control				
	Test 1	Test 2	T_2-T_1	Test 1	Test 2	T_2-T_1	t	Sig
White Collar	107.90	115.20	7.30	108.49	112.16	3.22	0.69	.5
Blue Collar	99.64	105.64	6.00	94.29	101.02	6.73	--	--

CHAPTER III

Summary, Conclusions and Recommendations

This research project was designed to answer four questions regarding the use of the Science Curriculum Improvement Study (SCIS) unit Material Objects in kindergarten.

1. Are the activities and concepts of the Material Objects unit appropriate for kindergarten children in terms of their abilities to deal with them effectively?

2. Are the activities of the Material Objects unit of such a nature that they interest kindergarten age children?

3. Will administering the Material Objects unit to kindergarten children significantly enhance their readiness for the tasks they encounter in first grade?

4. Will the cognitive stimulation of the Material Objects unit activities significantly improve intellectual functioning in kindergarten age children?

Questions 1 and 2 arise directly from claims either implied or stated directly by the SCIS project personnel. It is to these two questions that the maximum weight should be given in the overall evaluation of the Material Objects unit. The developers of the Material Objects unit do not claim that children who have had Material Objects will score higher on Metropolitan Readiness Tests or that the I.Q. of the participants will be increased, or that the child will progress at a faster rate in arithmetic skills or reading in first grade. These latter questions or aspects of the investigation originated with the principal investigator in this research and grew out of questions that had arisen in earlier research by the same investigator.

Also inherrent in the investigation of questions 1 and 2 was the assumption that the concepts and activities of the Material Objects unit represented valid science concepts and processes. This being the case, demonstration by the kindergarten children that they can deal with the concepts and activities of the Material Objects unit effectively would be at the same time proof of science achievement and a step toward a stated goal of the SCIS program, scientific literacy.

Questions 3 and 4 in the investigation are not an evaluation of the Material Objects unit per se, but deal with possible added benefits which might result. If these added benefits do result, they are above and beyond that which the unit is specifically designed to accomplish. If they do not result, that is, if children who have had Material Objects activities do not score higher on Readiness Tests than children who participated in a different science program or their I.Q. is not significantly increased, this must in no way be interpreted that Material Objects is not a valid unit for kindergarten.

The data pertaining to answer question 1 is given in Table I, page 7 , and Graph I, page 12 . Taken individually, there are certain stated objectives in the Material Objects unit with which a significant percentage of children did experience difficulty as is indicated by the columns beside the stated objective labeled "no" and "undecided."

As was stated in Chapter 2, there were only 17 cases in which at least eighty percent of the children did not achieve the stated objective. Of these 17 cases, only 4 actually had 20 % of the students marked "no" or did not achieve the stated objective. The other 14 cases had a large percentage of the students in the "undecided" columns indicating inconsistency of response on these objectives. Graph I showing that when considering the overall "yes," "no," and "undecided" responses, approximately 83% of the responses were "yes." Totaling the percentage of "yes" and "undecided" or "sometimes," the favorable response is approximately 90%. On the basis of the data, Question 1, "Are the activities and concepts of the Material Objects unit appropriate for kindergarten children in terms of their ability to deal with them effectively?" can be answered "yes."

The data collected to answer question 2 is displayed in Table II, page 14. When a comparison is made among the four classes, there is an appreciable variation in the percentage of student responses indicating that they "liked" or "disliked" the activity. This suggests that the attitude or approach used by the teacher might be a factor influencing the children's attitude toward the activity. Remarks by the teachers and personal observation by the principal investigator

and the assistant indicate that the activities which the children liked least were those involving activity sheets with no actual objects to manipulate. The percentage of "like" responses varied from eighty-eight to ninety-eight percent of the total. The overall percentage of "like" responses was ninety-four. Therefore, the answer to question 2, "Are the activities of the Material Objects unit of such a nature that they interest kindergarten age children?" is "yes."

In an attempt to provide an answer to question 3, "Will administering the Material Objects unit to kindergarten children significantly enhance their readiness for the tasks they encounter in first grade?" three approaches were used. First, do kindergarten children who have had Material Objects significantly outscore on the Metropolitan Readiness Tests kindergarten children who have had the same kindergarten program by the same teacher but without Material Objects? Second, do kindergarten children who have had Material Objects increase in their ability to perform Piaget conservation tasks? And third, do children who have had Material Objects in kindergarten significantly outperform in first grade in the areas of reading and arithmetic those children who did not have the Material Objects unit? Approaches 1 and 2 are measures of readiness for first grade work, while approach 3 is a measure of performance.

The data from the administration of the Metropolitan Readiness test is organized in Table III, page 16 and Graph II, page 17 . The average score (61.78) of the Experimental group is at the 65 percentile rank and the average score of the Control group (58.27) is at the 57 percentile rank even though the average age of the kindergarten children was approximately four months less than the normative group for the test. The average scores place both groups at the high end of the average category which is interpreted as "likely to succeed in first grade work." This indicates that both the Experimental and Control groups were provided a program which gave them adequate readiness for first grade work. When the Experimental and Control groups are sub-divided on the basis of I.Q.[7] into above average, (I.Q. > 110) average, (I.Q. 90-110) and below average, (I.Q. < 90), the readiness scores of both Experimental and Control groups fall into essentially these same categories suggesting a high correlation between I.Q. and readiness scores. It should be noted that on every basis of comparison on the total readiness scores average, the Experimental group outscored the Control group. It

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[7] I.Q. scores are those measured at the beginning of the kindergarten program.

must also be stated, however, that on no basis of comparison between Experimental and Control groups was the value of Fischer t large enough to give a high level of statistical significance. Also, as shown in Table VI, page 24, the average I.Q. scores for the Experimental and Control groups sub-divided into the same groups as Table III, the average I.Q. scores on each basis of comparison favors the Experimental group. Since, as has already been stated, I.Q. and readiness scores are positively related, the significance of the fact that the Experimental group outscored the Control group is further reduced. The Experimental group which had Material Objects, although the average scores were high, did not score significantly higher on the Metropolitan Readiness tests than the Control group.

The second basis of comparison of the Experimental and Control groups to determine if the Material Objects activities enhanced the children's readiness for first grade work was their increase in performance on Piaget conservation tasks. The data collected on pre- and post tests is presented in Table IV, page 18, Graph III, page 20, and Graph IV, page 21. The overall gain in conservations by the Control group (22) and the Experimental group (52) is significant in favor of the Experimental group at the .01 level of confidence using Chi Square. The pattern of increase in ability to perform Piaget conservation tasks is very similar to that reported by Stafford[8] in a similar study. The Experimental group did significantly outperform the control group in increase in conservation ability.

The third basis of comparison utilized to determine whether the Experimental group which had the Material Objects unit was better prepared for first grade work than the Control group was their scores in arithmetic and reading on the California Achievement Test-Form W. The data from the administration of these tests is presented in Table V, page 22, and Graph V, page 23. Again, the average of the Experimental group scores is higher than the average of the Control group scores in both reading (51.13 Experimental; 46.40 Control) and arithmetic (49.51 Experimental; 46.74 Control). On no basis of comparison, however, was the difference in scores on the California Achievement Test statistically significant at a high level of confidence.

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[8] Stafford, Donald G., Op. Cit.

Of the three approaches used to determine if the group which had Material Objects in kindergarten was significantly better prepared for first grade tasks, only one (Piaget conservation tasks) indicated significantly better performance at a high level of confidence. On the other two approaches, the Experimental group did perform better on every basis of comparison. The data collected to answer the question, "Will administering the Material Objects unit to kindergarten children significantly enhance their readiness for the tasks they encounter in first grade?" are inconclusive but favor the Experimental group. The data collected to answer the question "Will the cognitive stimulation of the Material Objects unit activities significantly inprove intellectual functioning in kindergarten age children?" is shown in Table VI, page 24 , Table VII, page 26 , Table VIII, page 27 , and Graph VI, page 25 . Both the Experimental and the Control groups showed gains in I.Q. as measured by the Science Research Associates (SRA) K-1 Mental Ability test.

A comparison of the overall gains in I.Q. by the Experimental and Control groups (Table VI) favors the Experimental group. When both the Experimental and Control groups are further sub-divided by pretest I.Q., the data reveal that the gains in I.Q. favor the Experimental group in the above 110 I.Q. group and in the below 90 I.Q. group. The control group outgained the Experimental group in the 90-110 I.Q. range. This suggests that the above average and below average children benefit most from the cognitive stimulation of the Material Objects activities.

Table VII, page 26 , which sub-divides Experimental and Control groups scores by I.Q. area on the SRA-K-1 test reveals that the only area in which the overall Experimental group made a substantial gain compared to the Control group was in the area of Perceptual.

Table VIIIreveals that the major advantage in I.Q. gains was in the area of Perceptual in the I.Q. divisions of below 90 and above 110. In the below 90 I.Q. range the average increase in Perceptual I.Q. was 24.70 compared to 12.72 by the Control group. This moved the Experimental group from the below average range to the high average range in perceptual I.Q. Similarly, in the above 110 I.Q. range, the gain in perceptual I.Q. strongly favored the Experimental group. (13.87 to 0.42)

It should be noted that in the 90-110 I.Q. division, Table VIII, that both Experimental and Control groups experienced a large gain of approximately equal magnitude in perceptual I.Q.

The gains in I.Q. recorded for the Experimental and Control groups subdivided by socio-economic grouping (white collar; blue collar) indicate almost no difference in the gains between the Experimental and Control groups in the "blue collar" categories. In the "white collar" category, however, the Experimental group gain more than doubled that of the Control group. Here again, the level of confidence is only at the .5 level.

The comparisons of the I.Q. scores of the Experimental and Control groups did not produce values on the Fisher t high enough to indicate a significant advantage in I.Q. growth by the Experimental group over the Control at a high level of confidence. (.05 or higher) Therefore, it can not be stated with complete assurance that the Material Objects activities do enhance the intellectual functioning of children more than the usual kindergarten activities. These data do strongly suggest that the possibility of increasing intellectual functioning in children does exist and must not be discounted. Furthur research in this area must be done.

As a part of the overall evaluation of the Material Objects unit for use in kindergarten, the four teachers and the project assistant who worked very closely with the teachers, were asked at the end of the year to respond to a series of questions. The teachers were told in advance that they should feel completely free to criticize any aspect of the program. The teachers were also reminded that their comments concerning the course might carry considerable weight, especially with other kindergarten teachers. The questions and the responses are given in Appendix II.

APPENDIX I

Material Objects[1]

Material Objects. In this unit children study common objects and special materials and describe them by their properties; such properties as color, shape, texture, hardness, and weight are considered. Properties are studied by the children as they observe, manipulate, compare, and even change the form or appearance of objects. As they compare properties and recognize the differences among similarly shaped pieces of aluminum, brass, lead, steel, pine, walnut, and acrylic, children assimulate the concept of material. Property comparison also leads children to the concept of serial ordering.

The pupils also investigate the properties of solid, liquid, and gaseous materials. Each child has many opportunities to apply what he has learned about material objects, their similarities and differences, the changes that may be brought about, and the need for observable evidence to support his conclusions. Near the conclusion of the unit, the children are introduced to simple experimentation. Experiments are done with floating and sinking objects, and air.

The Teaching Method. The SCIS curriculum model employs a consistent teaching strategy throughout each unit. The children are provided materials which they may explore thoroughly and completely. Since children learn most things through their own spontaneous behavior, the exploration phase of the SCIS model fits children very naturally. Spontaneous learning is limited, however, by the child's preconceptions.

There comes a time when he needs to be given a new concept which will then allow him to see the phenomenon he is observing in a new light. The teacher usually takes the children's ideas and provides a definition or a term for a new concept. When, for example, the children find that steel nails will be attracted to a magnet from any point in the space around that magnet, the teacher can now provide the name magnetic field for the space around the magnet. Sometimes a child will invent the concept himself.

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[1]John W. Renner and Donald G. Stafford, Elementary School Science, Bios, December, 1970, Volume XLI, Number 4, pp. 163 and 169-70.

After the child has the concept of magnetic field, he can now begin to ask himself many things about it. Will the magnetic field attract pennies? How far from the magnet can a steel nail be placed and still have the magnetic field attract it? The child can now discover many items of information about the new conceptual invention. Discovery is, therefore, only a part of the teaching method used by the SCIS program.

If you carefully consider how you truly become functional with any new object, event or situation, you find that you first learn all you can about it by involving yourself with it; in other words, you explore. You then provide yourself some type of label for referring to the concept your explorations uncovered; you engage in invention or request someone else to do it for you. After you have developed basic and probably initial understandings regarding the new phenomenon, you try to extend those understandings by discovering all you can about the object, event, or situation from the frame of reference of the new conceptual invention. You have, in short, asked the object, event, or situation about itself, and that *is inquiry*. *Discovery*, therefore, contrary to much of the existing literature, is not equivalent with inquiry. Rather, discovery is a part of the entire inquiry process.

APPENDIX II

Question 1: What is your opinion of Material Objects as a Readiness program for first grade work?

Crownover:

This is my first year to teach Kindergarten and therefore my answer to this question, as well as the others, should carry relatively little weight. As an elementary music teacher for many years, the only thing I had to offer the Kindergarten job was experience with children who were not a captive audience--that is, to make a music class meaningful, I practiced doing, not talking. In essence, I feel this is the same approach to be used for Kindergarten.

I feel that Material Objects can be used very effectively as a readiness program for first grade, along with numerous other approaches. I would dislike limiting myself to Material Objects as the Readiness program, just as I would not be happy with being restricted to any other one program of readiness, preferring to draw from various methods as the needs of different groups are perceived.

Hagar:

In my opinion the children were more aware of their environment through the study of Material Objects. Their observation and discrimination habits were developed and the child's vocabulary was greatly increased.

Opton:

I think Material Objects as a Readiness program for first grade would be good, because the child has a chance to express his own thoughts, draw his own conclusions and accomplish tasks without help from teacher or adults.

Salyer:

Since this is my first year in working with Kindergarten children, my judgement of a Readiness program for first grade might not be as reliable as that of some with more experience.

My opinion is that Material Objects fits in very well with and enriches the readiness program. The simple concrete experiences provide the child with opportunities to observe, to experiment, and learn through doing. Much of the material is especially good for

number readiness (sorting-sets-subsets-serial ordering and comparisons). Increases visual perception which is a very important goal in the readiness program.

Altmiller:

I feel that a child who has had Material Objects will have a better chance and show more progress in first grade. I found it an excellent way to help children develop readiness skills important to learning to read and numbers.

Question 2: Could the majority of the children do the activities in the Material Objects effectively?

Crownover:

It is very difficult for me to determine the degree of effectiveness with which most of the children could do the activities in Material Objects. With seventeen kindergarteners doing these types of activities simultaneously and with their attention span relatively short, I was never really sure that I accurately ascertained the degree to which a child understood what he was doing. It would be helpful to have an aide or another teacher in the room during these activities to merely observe and make notes as to how effectively individual children did the activities. The group as a whold did the activities in Material Objects effectively. Whether this was due to the leadership of several very intelligent children I happened to have in the group with the others merely "doing what so and so was doing" was often hard for me to know.

Hagar:

The majority of the children were able to do the activities with a degree of success.

Opton:

I think the majority of the children could do the activities in Material Objects effectively. As it teaches him to recognize Material Objects in his own environment. My children seemed very eager to attempt the activities.

Salyer:

Most of activities in Material Objects could be done by the children. Some, however, should be revised, simplified and made more applicable to Kindergarten children. Names of metals, woods and rocks were not especially interesting to them and were a little too difficult. They were interested in sorting and giving their properties.

Altmiller:

The children could do all the activities that are presented. Some of the children did them more easily than others but all were eventually successful. It was very satisfying to the children because they were successful.

Question 3: Could you detect a carryover from the Material Objects activities and ideas to other activities?

Crownover:

I think so. The children exhibited most of the traits that a proponent of SCIS would hope for, i.e., curiosity,, many questions asked about all phenomena which they observed that they did not understand, the ability to form, with some guidance from the teacher, a plan to investigate why these phenomena behaved as they did, persistent observation and active participation as the problem solving plan evolved, and finally, an answer satisfactory to the student. In all fairness, I must say that the particular group of children with whom I had Material Objects were, as a whole, intelligent, alert, inquisitive children and with my enthusiasm for the inquiry approach to teaching, this group might have had the same general attitudes about problems and how to solve them without Material Objects. I do think Material Objects is a perfect vehicle for achieving these attitudes.

Hagar:

Yes, there was evidence of a carry-over from the Material Objects activities and ideas to other activities.

Opton:

Definitely. I could detect a carryover from Material Objects activities and ideas to other activities. Especially in math, sets and subsets, it increases the child's vocabulary, he observes differences and similarities, and is helpful in language arts. In all activities we bring out something we had in science.

Salyer:

I think there was a noticeable carryover especially in numbers, individual and voluntary contributions in class discussions and visual perception.

Altmiller:

I was unable to see or know if this was done.

Question 4: What were your childrens' attitude toward Material Objects activities?

Crownover:

Most of the children enjoyed the activities.

Hagar:

The children's attitude toward Material Objects activities was one of pleasure. They looked forward to our science activities. Through field excursions, games and a variety of experiences which helped develop their thinking pattern.

Opton:

They were very enthusiastic toward Material Objects activities. Of course some activities they liked better than others, but the collection of buttons, wooden blocks and rocks were enjoyed by all.

Salyer:

Most of the activities were enjoyable, some more than others. The children did not enjoy doing the worksheets. They were too difficult and not interesting to Kindergarten age children.

Altmiller:

The children all seemed to enjoy the things we did. They seemed to look forward to our times together and I certainly did.

Question 5: How much time did you spend on the average on an activity?

Crownover:

The children's sessions usually lasted about 20 minutes, although we often used the same activity for other sessions, varying the approach slightly, or pursuing the same activity in depth or starting where we had left off--sometimes in the middle of an activity if the children grew tired of it before we had achieved the overall purpose of the activity.

Hagar:

On the average I would judge we used two periods of approximately twenty minutes, on each activity.

Opton:

When we first started the science program we spent several days on one activity. Then we cut it down to one lesson for one activity--unless we didn't finish--on the average of 20 to 25 minutes for a lesson.

Salyer:

About 20 minutes.

Altmiller:

The activities that I taught were about ten minutes in length.

Question 6: How much time on the average did you need to get ready for an activity?

Crownover:

Fifteen to twenty minutes, depending on how many materials were to be used, were spent in actually getting the trays set up, etc. Since the unit was new to me, I possibly spent an average of 30 minutes preparation time reading the activity, thinking how I wanted to handle what I anticipated would happen, etc. I reviewed it perhaps 15 minutes the day I actually went into the activity.

Hagar:

In getting ready for an activity in science, we spent approximately two hours.

Opton:

To prepare lesson, make notes, re-study and set up activity, ready for class would take between one and two hours.

Salyer:

From 30 to 45 minutes depending on activity and type of material to be used.

Altmiller:

It took me about ten or fifteen minutes to prepare the activity.

Question 7: How, in your opinion, should the activities be paced during the school year, i.e., should the program be started immediately after school starts in September; much time be spent on early activities such as grab bags, button box, giving properties, etc.?

Crownover:

I would think the first or middle of October would be a good time to start. I do think that more time needs to be spent on the first eight or ten lessons--the concept of objects having properties being firmly established before going on to other activities. The children seemed to be ready to move more rapidly through the last half of the book.

Hagar:

In Kindergarten I think the program should be started approximately from four to six weeks after the beginning of the school term.

Opton:

I do not think the program should be started immediately after school starts in September but wait at least five or six weeks. (October) I think more time should be spent on early activities. That is what I did. I started out spending three or four lessons on one activity. The children enjoyed grab bags, button box, etc.

Salyer:

The program should not be started for about 3 or 4 weeks after school begins. Time spent on activities should be judged by your group and interest of group in a certain activity. Many activities could be returned to at a later date, with renewed interest--grab bags could be used throughout the year--button box could be used for several activities during year especially in numbers, serial ordering and comparison signs.

Altmiller:

I think the kit is designed just right for kindergarten. It is so leveled that each activity is placed along just right, I feel. If the kit were taught consistently, i.e., each day, it would add much to the kindergarten program.

Question 8: What are your feelings concerning the degree of structure imposed on the kindergarten program by Material Objects?

Crownover:

It is more structured than I would choose for kindergarten. I think the inquiry method of teaching superior to any, I like the materials in the Material Objects unit, and I think the purposes of each

of each activity have much to offer a 5 year old in opening his eyes and mind to the world in which he lives. I look forward to blending the splendid materials into a relevant, less structured program in my kindergarten class next year.

Hagar:

In some instances, the material was too advanced for Kindergarten. Also, in some of the activities there were not enough suggestions, as how to use the material. On some of the worksheets the pictures were too small and there were too many objects on the page, for kindergarten. More color on the worksheets would be good.

Opton:

Some material was too advanced for kindergarten--especially some work sheets. But as a whole, the kindergarten children enjoyed all the program of Material Objects.

Salyer:

Material Objects as was taught during the Pilot Program was perhaps too structured for kindergarten. The material should be used at any time with any subject or discussion when and where it could serve as a vehicle for learning.

Altmiller:

The structure was so slight that it fitted exactly into the kindergarten program. The activities were planned so that each group of children could be as creative as they desired and use the activity in many different ways. It was wonderful having all the different kinds of equipment for the children to use.

Question 9: Could you detect any appreciable difference in the class which had Material Objects during the year and the one that did not with respect to their curiosity, i.e., did they ask more questions, show more curiosity, indicate a greater willingness to physically explore, comments from parents, willingness to express opinions?

Crownover:

It is very difficult for me to compare one group of children with another group in regard to specific traits such as mentioned in this question. The group having Material Objects were more curious, asked more questions, were very definite in their opinions and loved

to express them by October 1--before we started Material Objects. My control group overall had lower I.Q.'s, approximately 1/3 of them were from economically deprived homes, their pre-school experiences were much more limited than the other group, travel in a majority of the families had been virtually nil--so it would follow that these children in the control group were not as curious, etc. as the Material Objects group. I really cannot give an opinion as to the degree that the Material Objects furthered inventiveness, etc.

Hagar:

An appreciable difference in the class which used Material Objects during the year was noticed. The children were more curious and loved to explore further.

Opton:

At kindergarten age all children are curious, but the class that had Material Objects were exposed to more things, therefore they did ask more questions. They observed more in plant and animal life, ask more questions about liquids and gases, as well as solids.

As to comments from parents, I never mentioned one class having a different science program.

Salyer:

The children who had Material Objects seemed to have a greater awareness of objects and were able to describe things well because they had a meaningful vocabulary with which to express their observations. The associations they were able to make seemed to be broader, in some cases, than those of the other group--(It is very hard to compare groups of children in regard to one subject.)

Altmiller:

I did not work with both groups.

Question 10: Has teaching Material Objects in the experimental class influenced your teaching in the control class?

Crownover:

Yes.

Hagar:

Yes, definitely, I found myself using terms used in the experimental class and I was more eager to teach the control class in science.

Opton:

Yes, teaching Material Objects in the experimental class has influenced my teaching in the control class. You have more desire to let the child discover for himself through observation. Guide, but let the child make his own conclusions independently.

Salyer:

I think teaching Material Objects has influenced my teaching in that I try very hard to be a better listener, to stimulate rather than impose an opinion or answer--I try to "ask" more and "tell" less.

Altmiller:

I did not work with both groups.

APPENDIX III

Description of Conservation Tests Used in the Kindergarten Research Project

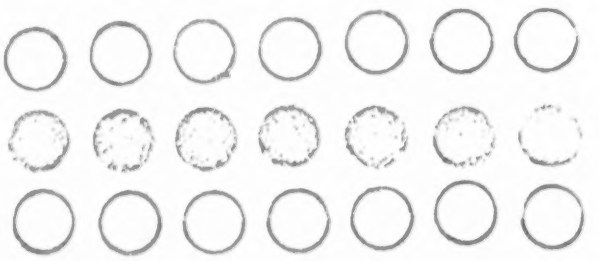
Method of Testing

The child was seated at a table on which clay, checkers and various other materials used in the tests were placed. The tester would then say, "I would like for you to help me by answering the questions I am going to ask you about these objects. You may touch any of the objects we are talking about if you want to and I want you to tell me just what you think when I ask a question." Each child was given as much time as he wanted to think before replying to a question.

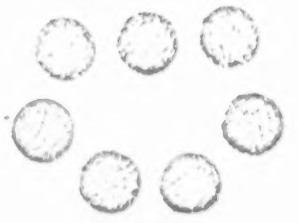
The individual tests were conducted in the following manner:

1. Conservation of Number: A stack of red and a stack of black checkers were placed in front of the child. The child was then told that the tester was going to form a row of black checkers and that each time the tester placed a checker into the row, the child was to place a red checker alongside it so the two rows would contain the same number of checkers. Seven checkers of each color were used to make each row (see arrangement A following) so that the child could count them if he desired. After completion of the row, the tester asked the child if each of the two rows contained exactly the same number of checkers. When the child agreed that each row did contain the same number of checkers, the tester would then rearrange the black checkers to form a circle (see arrangement B following) and again ask if the numbers of black and red checkers were the same. If the child indicated that the numbers of checkers were still the same, this was taken as adequate evidence that he conserved number.

Arrangement A



Arrangement B



2. Conservation of Liquid Amount: Three glasses, two wide measuring glasses of equal size marked in one-eighth cup gradations and one tall narrow unmarked cylinder were used in this test. The two wide glasses were filled to the one cup mark with red colored water. The child was then told, "Let's pretend we are having a party and this is your kool-ade and this one is mine. Do we have the same amount to drink?" If the child asserted that each glass did contain the same amount, the test continued. If the child suggested that one glass contained more or was not certain, he was asked to add or take away liquid until he felt certain they were the same (see arrangement A following). At this point, the tester poured his glass of kool-ade into the tall narrow cylinder (see arrangement B following). He then repeated the question, "Do we each have the same amount to drink now?" An affirmative answer was taken as evidence that the child conserved liquid amount.

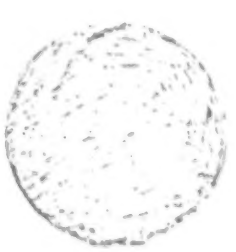
Arrangement A

Arrangement B

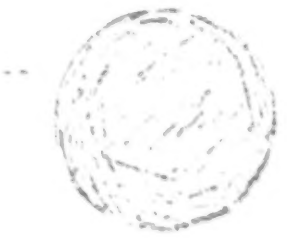
3. Conservation of Solid Amount: Two balls of red plasticene were placed in front of the child. The child was then told to imagine that this was something very good to eat and was told, "This is your piece to eat and this one is mine. Do we each have the same amount to eat?" If the child agreed that each ball contained the same amount, the test continued. If he did not believe the two amounts were the same, he was requested to take from one ball and add to the other until they contained the same amount to eat. When the child had decided that each ball contained the same amount to eat, the tester would take one ball and, in full view of the child, flatten it into a pancake shape and again place it alongside the ball. Pointing to the pancake-shaped piece of plasticene, the tester would say, "This is my piece to eat and that one is yours. Do we have the same amount to eat?" An affirmative answer was considered to be adequate evidence that the child conserved solid amount.

4. Conservation of Weight: Two balls of blue plasticene approximately the same size were placed in front of the child. One ball was then handed to the child with the question, "Is it pretty heavy?" When the child's attention was considered to be focused on the heaviness of the ball, the second ball of plasticene was handed to the child with this question from the tester, "Is this ball just as heavy as the other one or is one ball heavier than the other?" If the child agreed that the balls were equally heavy, the test continued. If the child asserted that one ball was heavier, he was asked to take from one ball until they were equally heavy. After the child had decided that each ball was equally heavy, the tester would take one ball and, in full view of the child, form the plasticene into a bowl. The tester then placed the bowl open side down in front of the child and beside the ball. He then asked, indicating each object in turn by placing his finger on it, "Is this one just as heavy as this one, or is one of them heavier?" The child was allowed to pick up the pieces of plasticene if he wanted to for comparison (and almost all did). If the child's reply indicated that he believed the two objects still weighed the same, this was taken as evidence that he conserved weight.

Arrangement A

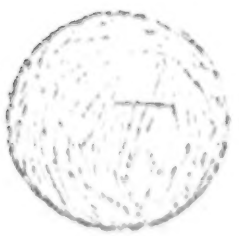


Cross sectional view



Cross sectional view

Arrangement B



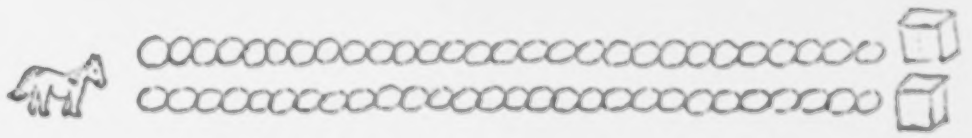
Cross sectional view

Cross sectional view

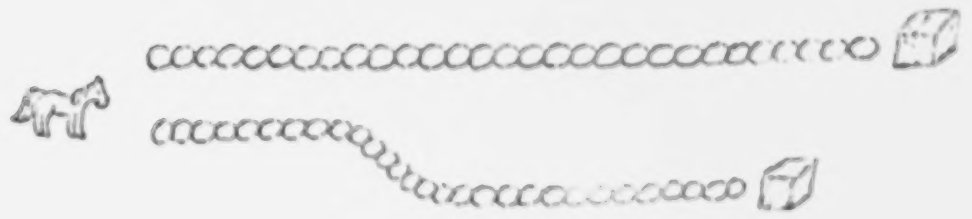
57

5. Conservation of Length: The materials for this test consisted of two identical strings of beads, a small plastic horse, and two cubes of wood. The two strings of beads were laid side by side on the table in front of the child so that the ends matched. The child's attention was called to the fact that it was just as far from the end of one string of beads as it was from the other. The child was then told, "Let's pretend that each string of beads is a road. I am going to place hay at the other end. If the horse walks down either of the roads, it would be just as far to the hay." (See arrangement A following.) When the child had agreed that the distance was the same, the tester then bent one string of beads as shown in Arrangement B following and asked, "Now, if the horse must follow the road, would he have to walk as far to the hay on one road as on the other?" If the child stated that the horse had to travel the same distance in either case, this was taken as evidence of conservation of length.

Arrangement A



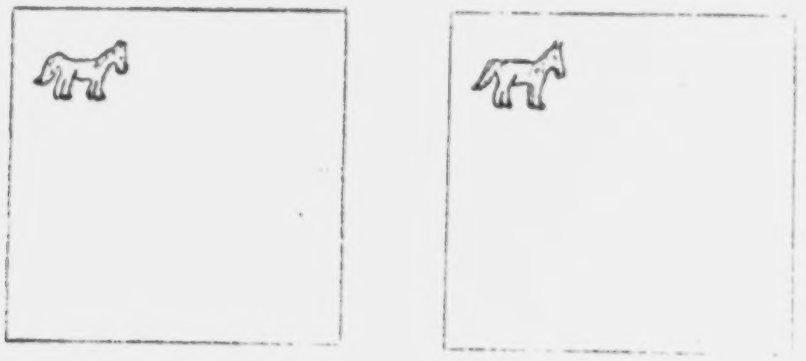
Arrangement B



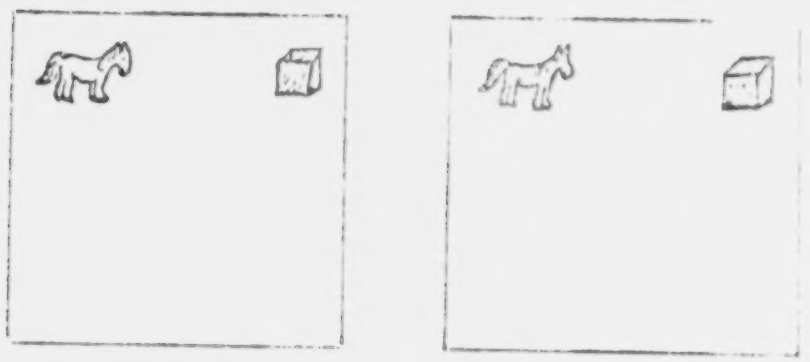
6. Conservation of Area: The materials for this test were two sheets of green poster board, each one foot square, two plastic horses, and six red cubes three-fourths of an inch on each edge. The two sheets were placed in front of the child one stacked on the other to show they were equal in size. The sheets were then separated and placed in front of the child. The tester then told the child, "Let's pretend that each of these is a patch of grass and there is just as much grass on one patch as the other." A small plastic horse was placed in the same position on each board with the comment, "Each horse may eat all of the grass in his patch if he wants to and one has just as

much to eat as the other. (See arrangement A following.) Now I'm going to build a barn on each patch of grass and cover up *some* of it so that the horse can't get to it. (See arrangement B following.) Is there just as much grass left for one horse to eat as the other?" If an affirmative answer was given at this point the test continued. If a negative answer was given and maintained after the test was repeated to this point, as it was in two instances, the child was listed as a non-conserver. Those children who answered affirmatively were then told, "I am going to build two more barns on each patch of grass, but I am going to build them beside the first barn on one patch of grass, and spread them out on the other patch. (See arrangement C following.) Does each horse still have the same amount of grass to eat or does one have more than the other?" An answer indicating that each horse still had the same amount of grass to eat was accepted as evidence that the child conserved area.

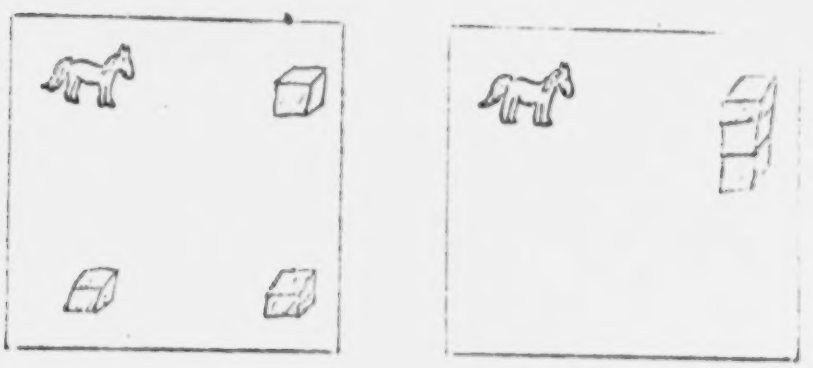
Arrangement A



Arrangement B



Arrangement C



APPENDIX IV

Sample Data Sheets

Sample Pages of Teacher Rating Booklet

Rating Scale For SCIS Material Objects Activities

District_____ School_____

Name of pupil_____ Grade_____

Name of teacher_____ Class Time_____

Note To The Evaluator

The purpose of this rating scale is to determine whether or not the pupil meets the stated objectives of the activity at the time of its completion. Individual observation will be required and may be done on an informal basis throughout the activity period. Special interviews or observations in small groups will be required for those pupils who have not consistently shown the behavior involved before the end of the activity. The behavior to be rated must be shown without prompting from the teacher or the other pupils.

Prepared by Donald Stafford, Wendell Altmiller and Roy Maxwell through the Research and Development Office, East Central State College, Ada, Oklahoma. Objectives taken from Material Objects Teachers Guide.

Activity number one: Objects in the Classroom
Number of Class periods spent on activity_____

Objectives	Pupil reached objective by the time next activity was introduced. (Circle one)	
1. Uses the term object for a piece of matter	Yes	No
2. Uses the term property for any characteristic of a piece of matter	Yes	No
3. Identifies and describes material objects by their properties, not their use.	Yes	No

Sample Interest Rating Scale

Interest Rating Scale

Activity_____

Brief description of lesson:

Teacher_____Class time_____

Name of Pupil_____Date_____

Directions: If you liked what we have just been doing, put an X on the happy face; If you did not like what we have been doing, put an X on the sad face.

Interest Rating Scale

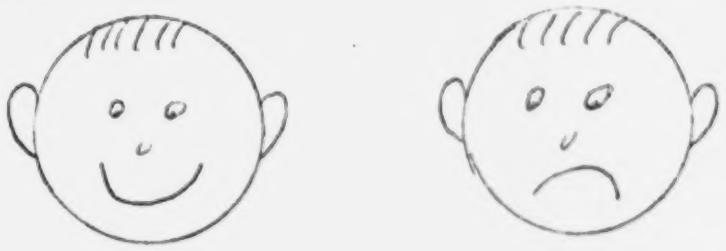
Activity_____

Brief description of lesson:

Teacher_____Class time_____

Name of Pupil_____Date_____

Directions: If you liked what we have just been doing, put an X on the happy face; If you did not like what we have been doing, put an X on the sad face.



Sample Sheet for Recording Individual
Child's Responses to Happy-Sad Evaluation

Name_____

	Happy	Sad
Activity 1		
Lesson 1	_____	_____
Lesson 2	_____	_____
Lesson 3	_____	_____
Lesson 4	_____	_____
Lesson 5	_____	_____
Lesson 6	_____	_____
Activity 2		
Lesson 1	_____	_____
Lesson 2	_____	_____
Lesson 3	_____	_____
Lesson 4	_____	_____
Lesson 5	_____	_____
Lesson 6	_____	_____
Activity 3		
Lesson 1	_____	_____
Lesson 2	_____	_____
Lesson 3	_____	_____
Lesson 4	_____	_____
Lesson 5	_____	_____
Lesson 6	_____	_____
Activity 4		
Lesson 1	_____	_____
Lesson 2	_____	_____
Lesson 3	_____	_____
Lesson 4	_____	_____
Lesson 5	_____	_____
Activity 5		
Lesson 1	_____	_____
Lesson 2	_____	_____
Lesson 3	_____	_____
Lesson 4	_____	_____
Lesson 5	_____	_____
Lesson 6	_____	_____

Sample Sheet for Compiling Data on Each Child

Name_____ Experimental_____ Control_____

Piaget tasks

	Pretest	Posttest
N	____	____
Le	____	____
Li	____	____
W	____	____
S	____	____
A	____	____
age		

Overall difference____

Occupation of parents_____
Welfare: Yes___ No___
Church preference:_____
Address:_____
_____
Sex: M____ F____
Date of Birth_____
_____

Reading test (1970-71)_____
Reading test average(69-70)_____

Act.	lessons liked	disliked	ach. beh. obj. Yes	No
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

I.Q.	Test 1	Test 2
Verbal	____	____
Perceptual	____	____
Number	____	____
Spatial	____	____
Total	____	____

I.Q.	Difference
Verbal	____
Perceptual	____
Number	____
Spatial	____
Total	____

Metropolitan Readiness Tests

Test	Score
Word meaning	____
Listening	____
Matching	____
Alphabet	____
Numbers	____
Copying	____
Total Score	____

Piaget Task Record Sheet

Name of child_____ Teacher_____

Pretest

Conservation Task	Conserved (circle one)	
Number	Yes	No
Length	Yes	No
Solid Amount	Yes	No
Liquid Amount	Yes	No
Weight	Yes	No
Area	Yes	No

Posttest

Number	Yes	No
Length	Yes	No
Solid Amount	Yes	No
Liquid Amount	Yes	No
Weight	Yes	No
Area	Yes	No